

**REMARKS**

Claims 8-16 and 21-31 are presently pending. Claims 14-16, 22-24 and 28-31 have been withdrawn from consideration. Claim 31 has been canceled herein. Claims 8-13, 21 and 25-27 have been rejected. Claims 8-12 have been amended. New claim 32 has been added.

**I. Timely Filed Response After Final**

A Final Office Action issued for this matter on October 19, 2005, and Applicants filed a Response After Final on November 21, 2005. Because November 19, 2005 fell on a Saturday, and the next business day became Monday November 21, 2005, this Response was filed within the two-month period for response after final. However, box 1a is checked in the pending Advisory Action, which indicates, "The period for reply expires 3 months from the mailing date of the final action." Applicants respectfully submit that this is incorrect, and that box 1b on the Advisory Action should have been checked, such that the period for reply expires on the mailing date of the Advisory Action. Accordingly, only a one-month extension of time should be required.

**II. Interview Summary**

Examiner Trinh is hereby acknowledged and thanked for the courtesy extended during the personal interview on January 17, 2006, at the United States Patent and Trademark Office between the Examiner and the undersigned attorney. The pending Final Office Action, Advisory Action, current claims, specification as filed and prior art were all discussed during this personal interview, with particular focus on FIGS. 6, 7A, 7B and the accompanying specification as filed, pending claims 8, 13, 26, and 27, and that which is clearly taught by the primary prior art reference used, U.S. Patent Publication No. 2002/0109228 A1 to Buchwalter et al. ("Buchwalter"). Agreement was reached with respect

to the criticality factor having been met for the presently claimed support coating height in view of the teachings of Buchwalter specifically. The Examiner could not agree that such a conclusion could be made with respect to all prior art, however, such that a new search would be required. Several further claim amendments were also suggested, and these amendments have been made herein.

### **III. Withdrawn Claims**

Claims 14-16, 22-24 and 28-31 have been withdrawn from further consideration as being drawn to non-elected groups. Applicants note that claims 14-16 and 22-24 all depend directly or indirectly from independent claim 13, such that these withdrawn claims should be reinstated and allowed if claim 13 becomes allowed. Applicants also note that claims 28-31 all depend directly or indirectly from independent claim 8, such that these withdrawn claims should be reinstated and allowed if claim 8 becomes allowed.

### **IV. Specification**

The prior amendments filed by Applicants on July 5, 2005, have been objected to under 35 U.S.C. § 132(a) because they are alleged to introduce new matter into the disclosure. Applicants respectfully disagree, and submit that all prior amendments are supported by the original written description, figures and claims as filed. The Office Action identifies the following added claim elements as alleged new matter:

For claim 1 [sic, 8]:  
the resulting mid-level wetting angles remain sufficiently high such that said mid-level junctions do not become the primary location for solder joint failure, and the resulting first wetting angles are at least approximately 40 degrees

For claim 26:  
first wetting angles and mid-level wetting angles that are greater than about 50 degrees

For claim 27:

first wetting angles and mid-level wetting angles that are equal to or greater than about 60 degrees

Applicants respectfully submit that these amendments of claims 8, 26 and 27 do not introduce new matter, and for support point to paragraphs 0037 through 0041, FIGS. 6, 7A and 7B and claims 5 and 14 of the original application as filed. In particular, paragraph 0039 explains:

FIG. 7B shows a die-solder joint-substrate combination 300 that typically results when a support coating having a height of greater than about 70 percent of the overall solder bump height is formed on the active surface of the wafer. . . . *the mid-level angle 335 has been reduced substantially, such that it now becomes the primary location for solder joint cracking and shearing due to temperature cycle failure.* It thus becomes apparent that any advantageous use of a support coating to strengthen the solder joint connections must strike a balance between optimizing the solder joint to die wetting angle and optimizing the mid-level angle corresponding to the height of the support coating.

(emphasis added). The emphasized passage relates to an undesirable result that is found in items having a support coating height that is too high (i.e., outside the height ranges claimed). Preferable resultant wetting angles are also described at other locations, as noted, such that these claim amendments overall are supported by the original disclosure.

In addition, the specification has been currently amended to add the following sentence to paragraph 37: "In some instances, the final wetting angle 131 is at least approximately 40 degrees." Applicants respectfully submit that this current addition does not comprise new matter, as this specific wetting angle property was first submitted in at least original claim 5 in the specification as originally filed.

#### V. Claim objections

Claims 8, 26 and 27 are objected to due to informalities. Applicants assume that these objections are being made with respect to the terminology "at least approximately 40 degrees," "greater than about 50 degrees," and "greater than about 60 degrees." Applicants respectfully submit that this claim language fairly reflects that which is being claimed, and

note that the use of relative terminology and terms such as "about" in claims is permitted. *See, e.g.,* MPEP § 2173.05(b). It is respectfully submitted that this particular claim language is not indefinite when read in the context of the full claims and accompanying specification.

#### VI. Claim Rejections under 35 U.S.C. § 112

Claims 8-12 and 25-27 stand rejected under 35 U.S.C. § 112, second paragraph. In particular, the Office Action states:

claim 8 recites the broad recitation of the range for the support coating's height such that the upper surface of the support coating meets the solder bumps, and the claim also recites that the height of the support coating is from about 20-70 percent of the pre-reflow height of the solder bumps which is the narrower statement of the range/limitation.

Applicants respectfully traverse these rejections and submit that these rejections reflect a fundamental misreading of the language of claim 8.

Claim 8 specifically recites, "a support coating formed . . . *such that mid-level wetting angles are formed at mid-level junctions where the upper surface of said support coating meets said solder bumps, . . . wherein the height of said support coating is from about 20 percent to about 70 percent of the pre-reflow height of said solder bumps*" (emphases added).

Applicants respectfully submit that the portion of claim 8 italicized above does *not* define or suggest any support coating height, much less a "broad recitation of the range for the support coating's height," as asserted by the Office Action. Rather, this italicized portion only serves to define where mid-level junctions and wetting angles are formed, which are "where the upper surface of said support coating meets said solder bumps." Applicants note that such a meeting location of upper surface support coating to solder bump is independent of the height of the support coating (providing, of course, that the support coating height does not exceed the solder bump height). One example of such a mid-level wetting angle is illustrated as item 135 in FIG. 6. The portion of claim 8 that is underlined above recites the only specification

for support coating height in claim 8, which is a range from about 20 percent to about 70 percent of the pre-reflow height of the solder bumps. As an example, should the support coating height actually be at 20 percent of the pre-reflow height of the solder bumps in a given application, then the mid-level wetting angles will be formed at mid-level junctions that are at 20 percent of the pre-reflow height of the solder bumps (i.e., where the upper surface of the support coating meets the solder bumps).

Because none of rejected claims 8-12 and 25-27 set forth any conflicting broad and narrow ranges of support coat height within the same claim, the pending rejections under 35 U.S.C. § 112, second paragraph cannot stand. Accordingly, Applicants respectfully request withdrawal of these rejections.

#### **VII. Claim Rejections under 35 U.S.C. § 103**

Claims 8-13, 21, 25-27 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Buchwalter et al. (2002/0109228 A1) ("Buchwalter") alone. In particular, the Office Action states, "it would have been obvious . . . to modify the invention of Buchwalter with a specific range for the support coating's height," and also, "that the specification contains no disclosure of the critical nature of the claimed dimensions." Applicants respectfully traverse these § 103 rejections, and in so doing incorporate all arguments set forth in the prior amendment filed by Applicants on July 5, 2005.

#### **Criticality of Claimed Height**

As was done in this prior amendment, Applicants again note that significant portions of the written description and figures as filed are devoted toward the criticality of providing a support coating having a specific height range with respect to the solder bumps. In particular, paragraphs [0039] through [0041] and FIGS. 5A through 7B of the application as originally filed directly address the need for specific height ranges for the support coating. These

passages and figures disclose the importance of such height ranges and the undesirability of support coating heights outside of these ranges. For example, paragraph [0039] begins:

**It should be noted, however, that the height of the support layer relative to the solder bump and the amount of solder paste used on the substrate must be reasonably controlled to have the best results.**

Paragraphs [0039] and [0040] continue by discussing the problems inherent to support coatings having a height of less 20 percent and those having a height of greater than 70 percent of the overall solder bump height, namely that "very little solder bump collapse has been prevented" when the support coating height is less than about 20 percent, and that "the mid-level angle 335 has been reduced substantially, such that it now becomes the primary location for solder joint [failure]" when the height is greater than about 70 percent.

Paragraph [0041] then states:

**Experimentation has determined that final heights for the support coating that go lower than about 20 percent and higher than about 70 percent of the original solder bump height result in solder joints that tend to be progressively weaker as the percentage extends from this range. . . . [Beneficial] results certainly occur when the final height of the support coating falls between about 20 percent and about 70 percent of the original solder bump height. More preferably, the final height of the support coating should be at about 40 to 60 percent of the original height of the solder bumps, and even more preferably, the support coating height should be at about 48 to 52 percent of the original height of the solder bumps. It is thought that the ideal final height of the support coating is about 50 percent of the original solder bump height.**

Applicants respectfully submit that the foregoing passages and accompanying figures are more than adequate to establish criticality of the claimed height ranges, and respectfully request clarification of the statement that the present "specification contains no disclosure of the critical nature of the claimed dimensions."

**Failure of Buchwalter to Suggest Claimed Height**

As noted previously, Buchwalter never teaches or suggests a support coating having a height of 70 percent or less of its solder bump height. In fact, Buchwalter teaches only of underfill layers having heights *greater* than 70 percent of its solder bump height, and in many

cases greater than 100 percent of its solder bump height. In both embodiments, Buchwalter teaches a "bilayer wafer level underfill," whereby two separate polymeric layers are formed on a surface of a semiconductor wafer in such a way that its solder bumps are *entirely covered* (Buchwalter, paragraphs [0013]-[0018]; FIGS. 1F and 2D). Thus, the combined height of the two polymeric underfill layers is greater than 100 percent of the solder bump heights in either embodiment. In both embodiments of Buchwalter, the top layer of this bilayer underfill is diffused during bonding only to expose an upper surface of each solder bump, whereby a full and complete underfill is created; i.e., its "solder joints are completely surrounded and reinforced by the underfill" (Buchwalter, end of paragraph [0049]).

Applicants point out that Buchwalter appears to teach a first layer having a height that is about 90 to 100 percent of its solder bump height, and reiterate that even under a worst case scenario, the height of the first layer of Buchwalter's bilayer underfill cannot be less than 71.4 percent of the solder bump height. Applicants again submit that any suggestion that it would be obvious to lower the height of the underfill layer of Buchwalter would fly in the face of that which is taught by the reference. A prior art reference must be considered in its entirety, including portions that would lead away from the claimed invention. MPEP § 2141.02. Buchwalter teaches of underfill layers that are fully applied at the wafer level only, such that *only a surface* of a solder bump is to be exposed for bonding purposes. In both of its embodiments, Buchwalter teaches that its solder bumps are fully covered by its pre-applied underfill layers, and that the top surfaces of its solder bumps do not even become exposed until the bonding process is underway. As such, any alleged "optimization and experimentation with a specific range for the height of the support coating relative to the bumps" would be inapplicable to Buchwalter based on its own teachings.

Further, the second pre-applied underfill layer in Buchwalter is intended only to be a thin and dispersible adhesive layer, such that there is no motivation or incentive to increase

the thickness of this layer. Thus, it would not be obvious to modify Buchwalter to specify a support coating height that is at about or less than 70 percent of the height of the solder bumps. Because each of the pending claims requires that the "the height of said support coating is from about 20 percent to about 70 percent of the pre-reflow height of said solder bumps," all claims are patentable over Buchwalter for at least this reason.

In addition, and as noted during the personal interview of January 17, the most appropriate comparison between the teachings of Buchwalter and the present disclosure would be with respect to FIG. 7B and the accompanying description in the present disclosure.

Paragraph [0040] states:

**FIG. 7B shows a die-solder joint-substrate combination 300 that typically results when a support coating having a height of greater than about 70 percent of the overall solder bump height is formed on the active surface of the wafer. As can be seen, the "snowman" like shape of the solder joint is even more exaggerated in this example. This result is favorable in that almost all solder bump collapse near the die has been prevented, such that the solder joint to die wetting angle is virtually the same as the wetting angle prior to reflow. Unfortunately, the mid-level angle 335 has been reduced substantially, such that it now becomes the primary location for solder joint cracking and shearing due to temperature cycle failure. It thus becomes apparent that any advantageous use of a support coating to strengthen the solder joint connections must strike a balance between optimizing the solder joint to die wetting angle and optimizing the mid-level angle corresponding to the height of the support coating.**

(emphasis added).

Since Buchwalter teaches a first underfill layer having a height of about 90 to 100 percent of the solder bump height, Applicants respectfully submit that the described problems for support coating heights of greater than about 70 percent of the solder bump height would be exacerbated in Buchwalter. That is, the primary location for solder joint cracking and shearing due to temperature cycle failure will become Buchwalter's analogous "mid-level angle," that being the location where the top of the first underfill layer meets the solder bumps of Buchwalter. Unlike the present invention however, there will be much more relative compression in the unsupported 0 to 10 percent portions of the solder bumps in



Buchwalter, resulting in substantially more acute mid-level wetting angles and a substantially greater rate of failure at these mid-level wetting angles. Because Buchwalter expressly teaches away from "single-layer wafer-level underfills" (see, e.g., Buchwalter, paragraph [0009]), and does not address and is not concerned with mid-level wetting angle failure, it would not be obvious to modify Buchwalter as has been proposed for at least this reason.

For at least the foregoing reasons, it is respectfully submitted that none of the pending claims are rendered as obvious by Buchwalter. Accordingly, Applicants respectfully request that the pending obviousness rejections be withdrawn.

### CONCLUSION

Applicants respectfully submit that all claims are in proper form and condition for patentability, and thus request a Notification of Allowance to that effect. Appropriate consideration for the RCE and extension of time fees due is being submitted herewith. If such consideration is inadvertently omitted, or if any other fees are due in connection with this Response or for this application in general, however, then the Commissioner is hereby authorized to charge such fees to Deposit Account No. 50-0388, referencing Docket No. NSC1P131X3. If there are any questions or issues remaining, the Examiner is respectfully requested to contact the undersigned attorney at the telephone number listed below.

Respectfully Submitted,  
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